Florence of Worcester mentions it as having been seen in

"A.D. 978.—At midnight [the 18th of the Kalends of May (14th April)], there was seen throughout all England a cloud, which was sometimes of a blood-colour, and sometimes fiery; it afterwards broke out into rays of different colours, and disappeared about daybreak." (Chron. Flor. Worc.)

Gaimar, in his "History of the English," repeats this in the following manner:—

"A.D. 978.—At night, as he [the murdered King Edward] lay in the moat, a heavenly light spread itself there; the light was bright (no wonder!) it very much resembled the sun. This ray came over the holy body—the top of it was in heaven."

Putting down 978 as the correct date, and which is confirmed by William of Malmesbury (so far as the death of King Edward is concerned), this year may be accepted as the one in which an Aurora was seen.

From the last date till the year 1052, I cannot find any mention of "blood"-phenomena, or direct references to auroral appearance, and again in this year the evidence is very vague; it says:—

A.D. 1052.—A tower of fire was seen at Ross-Deala, on the festival of St. George, during the space of five hours, blackbirds innumerable going into and out of it, and one large bird in the middle of it." (Chron. Scot.)

The next, still more puzzling, will be my last:—

"A.D. 1103.—In the province called Berkshire, in a place called Heamstede, *blood* was seen by many to flow out of the ground." (Chron. Flor. Worc.)

I think that it will now appear from this account that any attempt to lay down *one* meaning for the whole of the numerous mentions of blood-appearances must fail, although it is, in a few instances, very clear that an Aurora is meant; but it seems as if a distinctive interpretation must be applied to the entries above given. On the whole, it is quite certain that this phenomenon has been seen at very remote dates by the inhabitants of Britain and Ireland; also that the enigmatical "blood"-miracles were not confined solely to Ireland, but seem to have been revealed alike to the *Keltic* inhabitants of England and Wales. I say *Keltic*, because I find the majority of records among the Chronicles to relate more especially to the *Ancient Britons* and *Irish*, and in many cases I believe (as one may judge from the above chronology) the style of poetical descriptions and form of mythical allusions are Keltic. The well-known Druidical Hymns, which appear in old Irish literature, are fair specimens of what I mean. One in particular concludes a mythical story with, "and the third (brother), guided by the lightning from his brother's fingers, shoots an arrow at the swimming hag, who immediately disappears in a *pool of blood*."[*]

There are two vague poetical descriptions which I imagine to have been suggested by the Northern Lights, in Hesiod's "Theogony," where he describes the war between the Gods and the Giants in the West. (Elton's Translation.)

He says:—

> The gods from Saturn sprung, and those whom Jove
> From subterraneous gloom releas'd to light,
> Terrible, strong, of force enormous, burst
> A hundred arms from all their shoulders huge.
> (Lines 884—887.)
>
> . . . . Through the void
> Of Erebus, the preternatural glare
> Spread, mingling fire with darkness.
> (Lines 924—926.)

From astronomical calculations this war is stated to have taken place at the autumnal equinox in the year 756 B.C., and to have terminated at the era of Nabonassar; so that such an appearance *may possibly* have assisted Hesiod in composing this poem. The Hindu astronomers also seem to have heard of, or seen a heavenly phenomenon, which I imagine to have been something like an Aurora, if the hypothesis be true, that with the ancients natural phenomena were invariably made the themes of their verse, and were shrouded in allegorical descriptions. The most remarkable passage I have met with occurs in the Mahābhārata, Book i. chap. 15 (Wilkins's Translation):—

"They now pull forth the serpent's head repeatedly, and as often let it go; whilst there issued from his mouth, thus violently drawing to and fro by the Suras and Asuras, *a continual stream of fire*, and smoke, and wind, which, ascending in thick clouds replete with lightning, *it began to rain down upon the heavenly bands*, who were already fatigued with their labour."

The date of this supposed war is placed at 945 B.C.

If the foregoing passages be compared with what the "Prose Edda"[*] says, the hypothesis will not appear unreasonable. In the chapter on "The Twilight of the Gods, and the Conflagration of the Universe," it says:—

> Midgard's protecting ward
> Bravely fights and slays
> The serpent monster.
> Then shall all mankind
> The earth abandon.
>
> Dimm'd 's now the sun,
> In ocean earth sinks;
> From the skies are cast
> The sparkling stars;
> The fire-reek rageth
> Around Time's nurse,
> And *flickering flames*
> With heaven itself playeth.

The idea of "flickering flames" is original, or, at least, not borrowed from the Eastern poets, and, in my judgment, could only apply to the Aurora, it may be an extraordinary appearance of it; and as the Aurora, which has been seen in England this year, was also visible in India, I think it not at all unlikely that "a continual stream of fire," which "began to rain down," is a record of a similar extensive phenomenon.

Dec. 20 JOHN JEREMIAH

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[*] See Thierry, "Hist. de Gaull.," and Pritchard's "Eastern Origin of Celtic Nations."

[*] Mallett's "Northern Antiquities" (Bohn's Edition, 1847, p. 455).

BALLOON ASCENTS FOR MILITARY PURPOSES

III.

THE laws of the motion of a balloon, dependent on the change of level, appear to have been hitherto very little discussed from a scientific point of view. It is, however, a motion which can be procured very easily by throwing out a small quantity of sand, or of gas, if the balloon is properly constructed, and which is of great importance for any expedition in time of war, more perhaps than even the attempt at guiding its direction. The number of minutes required for descending from a great altitude as well as for ascending to a certain level, being the most important consideration for the aëronaut endangered by the vicinity of some foreign force, this was analytically examined by M. Dupuy de Lome. It is the first instance that I know of such a disquisition since Euler worked his equations relating to the elevation of an aërostatic sphere supposed to be inextensible, and to be carried away in the atmosphere with a certain amount of motive power due to the small specific gravity of the included gas. That beautiful analytical disquisition is the last ever written by the old philosopher, who was totally blind at the time. It was found written by him on the *tableau noir* where he was making his calculations on the very day before he died. He had received the intelligence of the great experiment tried by Mongolfier, and his excited brain had produced during the night that masterly piece of mathematical skill which was unhappily his last! This contribution to scientific ballooning is to be found in the "Mémoires de l'Académie des Sciences de Paris" for 1781, a date anterior to the experiment of Mongolfier, which is accounted for by the issue of the volumes being always later than the date inscribed on them. Another singularity is that Euler speaks of gas for filling the balloon, while Mongolfier's was merely heated air. We must not, however, give Euler the merit of having been the real inventor of *Charlières* or gas balloon, as Mongolfier believed that he prepared gas by burning damp corn-straw! Before returning to the questions considered by Dupuy de Lome, we may be allowed to mention that the use of gas enclosed in a gasholder of any description, was suggested by Blake in his lectures at Edinburgh, and by an Italian philosopher transacting business in London. Carvalho tried to give to the idea of Blake the shape of an experiment, but uselessly, for the want of a proper varnish, which was invented by Charles a few months only after Mongolfier's great experiment.

The principal difficulty for strangers to the scientific working of an aërostat, appears to be to draw a broad line between the *motive power* or *force ascensionnelle*, and the *space* offered for free dilatation without any gas being lost in the air, which space I will call *the dilatation chamber*, although generally there is no

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special balloon to allow for this, but the lower part of the balloon is left unfilled.

The *Géant* had a special balloon for this purpose attached to the bottom of the large one by a kind of short connecting tube of a very large diameter, and this balloon was called the *compensator*. The arrangement can be seen by the engravings showing the *Géant* in *aerial travels*.

If we suppose that we have at our disposal a balloon of india-rubber susceptible of any distension, we are in a position to assimilate the motion of our aërostat to the elevation of an *Atwood's Machine* moving upwards with a certain moving weight, without any other friction than that of the air. All the calculations and formulæ worked for that philosophical instrument can be used. $a =$ the weight of the air replaced; $b =$ the weight of the balloon including gas and everything; $\frac{a-b}{a}$ will be the motive power; the motion will take place according to the rule for accelerating powers in a medium where the pressure is diminishing, as is the case with the atmosphere when the balloon is ascending. If we pay no attention to the friction on the air, which is very small indeed when motion is slow, we have an acceleration of motion varying as t, and a height obtained varying as t^2, as is well known. If g' is the new motive power and g the motive power of the ordinary specific gravity, then $g' = g \times \frac{a-b}{a}$; $\frac{a-b}{a}$ remaining constant under the assumption we have given.

The best way to realise this assumption is to suppose that the balloon is partially empty when leaving the surface of the earth, and the assumption holds good as long as the balloon is not filled up by dilatation. The time taken by the dilatation to fill up the space allowed to it, regulates the level where the balloon can ascend without losing any of its motive power. This friction must be considerable in cases where the balloon is to be sent to a great distance from the earth. The chamber of dilatation must be chosen in proportion to that distance. At all events it must be calculated thus: R being the radius of the sphere $\frac{4}{3}\pi R^3$ is the maximum volume which the gas is able to take without escaping into the atmosphere, C being the weight of gas and Δ its gravity for each cubic metre $\left(\frac{4}{\pi} R^3 - \frac{C}{\Delta}\right)$ is the number of cubic metres which can be afforded for dilatation, S_0 H_0 being the actual pressure on the earth. The pressure can be diminished in the proportion $\frac{\frac{C}{\Delta}}{\frac{4}{3}\pi R^3}$ without the gas beginning to escape. If we call H_1 the altitude where this escape is to begin, we can write the equation $H_1 = H_0 \frac{\frac{C}{\Delta}}{\frac{4}{3}\pi R^3}$ To ascertain the actual value of the corresponding altitude, it is necessary to look at the empirical tables inserted in the *Annuaire du Bureau des Longitudes* of each year, and calculated for reckoning the altitude from actual barometric pressure. These tables were calculated by M. Mathieu on the assumption of the truthfulness of Laplace's equations given in his *Mécanique céleste;* but I suspect these assumptions are not sound, and may possibly mislead French aëronauts, while Prussians are watching them below ready to shell their balloon if it comes within range. But having instituted no direct measures for ascertaining the value of this law, aëronauts are obliged to make use of it. The calculations of M. Dupuy de Lome for carrying his intended balloon out of range suppose the truthfulness of the numbers of the *Bureau des Longitudes*. If in doing so aëronauts are not sure of escaping hostile bullets, they can at all events get rid of every analytical obstruction, which is certainly something.

When the escape begins, the motive power is not destroyed at once. It certainly diminishes at a very quick rate if the *appendix* is wide enough to give free issue to the gas, and the vertical motion is also rapid. If not there is some danger of explosion, as can easily be imagined. Generally aëronauts are very anxious to get rid of this danger, which can be done very easily by opening the escape valve. But this operation involves the aëronaut in a "sea of troubles," as the valve for discharging the gas is rendered gas-tight only by the application of a proper plaster. The only way of dealing rationally with that excess of gas is to have a proper vertical motion when the discharge begins. That condition is very easy to obtain if you start with a very small ascensional power indeed.

In the fraction $\frac{a-b}{a}$ is very small, and moreover if the fraction $\frac{\frac{C}{\Delta}}{\frac{4}{3}\pi R^3}$ is large enough, you can conduct your balloon very safely at any distance if you do not meet with dark clouds, or burning sun. You can get rid very easily of these conditions by disposing cleverly of your ballast, as will be very easily understood by everybody after some explanation. There is however a circumstance which is very annoying in our military ascents, and on which it may not be useless to say a few words: the necessity of going at a certain level before reaching the meridian of the enemy's lines. The aëronaut is therefore obliged to know that distance and the quickness of the motion of the wind, so that the fraction $\frac{L}{V}$ gives the number of minutes at his disposal to reach the level required above that dangerous meridian. $V =$ medium velocity of the wind, as obtained by balloons sent free into the air, $S =$ elevation which the enemy's bullets cannot reach, I suppose it to be 6000 yards. Having no proper experiments at my disposal, I beg leave to make that gratuitous assumption. M. Dupuy de Lome, in his contribution, speaks only of 3000 metres, but Krupp's cannon was not in operation when he was writing. $L =$ distance of enemy's lines from the workshop. It is of great importance to increase that distance as far as possible, and I advised the Government to take two starting stations, one from the northern bank to be used when the wind was blowing southerly, and one from the southern when the wind was blowing northerly, so that in every case aëronauts might cross the whole of our city. But the suggestion was disregarded. The solution adopted was to start in the night time! It is a singular mode, very unscientific, to solve an analytical problem, by the sending of the aëronauts either to the great ocean to be drowned, or to Norway to be frozen. The subject is far from being exhausted, as to the rebounding of the balloon according to the law of oscillatory motions. But fearing to extend my remarks to a length beyond the patience of my readers, I beg leave to end my contribution at this point, thanking the editor of NATURE for the hospitality exhibited towards a French aëronaut, and hoping to be more fully acquainted with the English scientific public on some future occasion.

W. DE FONVIELLE

SOCIETIES AND ACADEMIES

LONDON

Royal Society, Dec. 22.—"On the Constitution of the Solid Crust of the Earth." By the Ven. Archdeacon Pratt, M.A., F.R.S. In this paper the author applies the data furnished by the pendulum-observations recently made in India, to test the truth of the following hypothesis regarding the Constitution of the Earth's Crust, which he propounded in 1864, viz. that the variety we see in the elevation and depression of the earth's surface in mountains and plains and ocean-beds has arisen from the mass having contracted unequally in becoming solid from a fluid state; and that below the sea-level, under mountains and plains, there is a deficiency of matter, approximately equal in amount to the mass above the sea-level; and that below ocean-beds there is an excess of matter approximately equal to the deficiency in the ocean when compared with rock; so that the amount of matter in any vertical column drawn from the surface to a level surface below the crust is now, and ever has been, approximately the same in every part of the earth. In order to make this hypothesis the subject of calculation, the author takes the case of the attenuation of matter in the crust below mountains and plains, and the excess of matter below ocean-beds, to be *uniform*, to a depth m times the height above the sea-level or the depth of the ocean, as the case may be. The results are shown in the following Table, in which the numbers are the last figures in the ratio of the differences

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